

## **Effective Index Model for Propagation through Photonic Crystals**

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Through the control of material properties on the same size order as the wavelength of light, photonic crystals offer unique phenomena unavailable in conventional optical materials. The ability to tune the band structure of a photonic crystal through the shape, size, and the properties of its constituent parts allows the design of metamaterials with controlled anisotropy and sensitivities to frequency. Various researchers have modeled the propagation in different regimes of the photonic band structure, but limitations have prevented the application of these models to cover the large range of phenomena simulated today. This study develops an effective index model for photonic crystals that accounts for both the amplitude and the phase of light propagation. The band structure, calculated through the plane wave expansion method, is fit to models of anisotropic crystals. The results are applied to model the behavior of light in photonic crystals exhibiting negative index, superprism, and self-collimation behavior. Good agreement is found between the model and the propagation properties of Gaussian beams in photonic crystals. The development of a complete theory is essential to systematically design complex systems utilizing photonic crystal devices, such as negative index lenses, superprism based DWDM devices, and self collimation based micro-filters and waveguides.